

## Core Evolution in the Icy Galilean Satellites, and the Prospects for Dynamo-generated Magnetic Fields

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The apparent discovery of a dynamo-generated magnetic field at Ganymede by Galileo prompts a more detailed examination of the internal evolution of the cores of the icy Galileans. For Ganymede, thermal evolution of a core, based on the structural models in Mueller and McKinnon (1988, Icarus 76), predicts radiogenic heating to well in excess of the Fe-S eutectic temperature ( $\sim 1200$ - $1250$  K at core pressures; Fei and Bertka 1996, LPSC XXVII) by about 1 b.y. after core formation. The amount of sulfur is also plausibly large, based on chondritic abundances  $S/(Fe + S) \sim 25$  wt%, close to the eutectic composition at inner core pressures ( $\sim 20.5$  wt%). The formation of an initially liquid inner Fe-(Ni)-S core, possibly in excess of 1000 km in radius, should not be hindered by the "wetting angle" problem, both due to the large volume percent of melt likely and the relatively high  $fO_2$  expected (Gaetani and Grove 1996, LPSC XXVII). Over solar system history this core cools and solid-state convection in the silicate outer mantle ceases. At some point inner core freezing should begin. Significantly, however, it is very difficult to find a set of parameters that allow inner core temperatures to drop below the eutectic temperature (e.g., extreme concentration of radionuclides at the core-mantle boundary due to core volcanism). Thus the inner core should be freezing at present (within  $\sim 200$  K of the eutectic), and it is the chemical buoyancy of this process that may lead to dynamo action. If the sulfur content is low, then freezing of an iron innermost core would presumably mirror the terrestrial situation. Higher sulfur contents allow an interesting possibility: FeS may precipitate at the satellite center and rise buoyantly to remelt at higher levels and/or similarly iron may rain out from the top of the inner core; this "precipitation engine" may effectively drive a dynamo. The prospects for radiogenic heating preventing complete solidification of Europa's inner core are marginal (simply due to the core's smaller size), but tidal heating may have stabilized core temperatures there and allow a weak dynamo driven by thermal buoyancy. Callisto's core, if it exists, is similar in size to Europa's, but is not tidally heated. This research supported by NASA grant NAGW-432.

Abstract submitted for 1996 DPS meeting

Date submitted: LPI electronic form version 5/96

Division for Planetary Sciences Abstract Form

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Special instructions: Tue Aug 27 16:47:29 CDT 1996 Tue Aug 27 16:59:34 CDT 1996

Membership Status (First Author):

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